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SEASONAL DISTRIBUTION, MOVEMENT, AND FOOD HABITS OF WALLEYE AND SAUGER IN LEWIS AND CLARK LAKE

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SEASONAL DISTRIBUTION, MOVEMENT, AND FOOD HABITS OF WALLEYE AND SAUGER IN LEWIS AND CLARK LAKE

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PREFACE

Information summarized in this report was collected and analyzed from April 2002 through December 2005. Copies of this report and references to the data can be made with permission from the author or the director of the Division of Wildlife, South Dakota Department of Game. Fish & Parks, 523 East Capitol Boulevard, Pierre, South Dakota 57501.

I would like to thank the following individuals from the South Dakota Department of Game, Fish & Parks that helped with data collection, processing, analysis, manuscript preparation, and report editing: Jim Riis, Robert Hanten, John Lott, David Lucchesi, Jeff Shearer, Jason Sorensen, Gary Knecht, Kyle Potter, Brian Beel, Michael Bertrand, Jared Caba, Andy Carda, Richard Crandall III, Casey Griffith, John Wayne Kalda, Chris Mangus, Sylvester Schied, Robert Schunout, and Cade Steffenson. From South Dakota State University: Michael Brown and Brian Graeb helped with study design, statistical analysis and report editing, Chad Kopplin provided universal transverse mercator descriptions of the sampling sites, and Blake Davis helped collect field data. Jeff Schuckman and Phil Chvala from Nebraska Game and Parks Commission, Norfolk, Nebraska helped collect walleyes and saugers for tagging.

EXECUTIVE SUMMARY

Sauger and walleye movements in the Missouri River were assessed by attaching dangler tags to fish and evaluating the returns. Gill nets, trap nets, and electrofishing were used to collect saugers and walleyes from the Ft. Randall Dam to Gavins Point Dam reach of the Missouri River during spring 2002.

One hundred fifty-five saugers were tagged, with 11 tagged saugers caught and five harvested during the first calendar year post-tagging. First-year unadjusted angler exploitation was 3.2%. During 2002-2005, nearly 38% of the tags recovered were from saugers caught near the original capture location. Fourteen tagged saugers were caught downstream of the original capture site and five were caught upstream of the original capture site. The farthest a tagged sauger moved downstream was 21 kilometers and the farthest upstream was 43 kilometers.

Eight hundred thirty-four walleyes were tagged, with 122 tagged walleyes caught and 113 harvested during the first calendar year post-tagging. First-year unadjusted angler exploitation was 13.5%. During 2002-2005, over 48% of the tags recovered were from walleyes caught near the original capture location. Eighty-three tagged walleyes were caught downstream of the original capture site and 23 walleyes were caught upstream of the original capture site. The farthest a walleye moved downstream was 108 kilometers and upstream was 103 kilometers.

Sauger and walleye distribution in Lewis and Clark Lake were studied during spring, summer, and autumn. Variable mesh gill nets used to collect saugers and walleyes were 91.4 m long and 1.8 m deep with 15.2 m each of bar mesh sizes 12.7, 19.1, 25.4, 31.8, 38.1, and 50.8 mm. Thirty-six gill nets were fished overnight (approximately 24 h) on the bottom during each season. Three gill nets were fished in each of three sites at littoral and limnetic locations in both the upper and lower zones of the reservoir. A total of 36 gill nets were fished during each season.

Generally, sauger catch-per-unit-effort (CPUE) was significantly higher in limnetic locations than littoral locations. During spring and summer, CPUE was significantly higher in limnetic locations in the lower zone. Walleye CPUE was commonly significantly higher in limnetic locations than littoral locations in the upper zone. However, during spring, walleye CPUE was significantly higher in littoral locations than limnetic locations in the lower zone and during autumn there was no difference.

In general, significantly longer saugers were caught at limnetic locations and the upper reservoir than at littoral locations or the lower reservoir. Conversely, this difference did not prevail during spring when longer saugers were caught in littoral locations or during autumn in the lower reservoir. No consistent pattern was evident for mean walleye length and reservoir locations.

No significant difference in sauger relative weight (*Wr*) was found among seasons or between locations in Lewis and Clark Lake. No general pattern for walleye *Wr* was evident, but some significant differences were found. Quality-preferred length walleyes had significantly higher *Wr* than stock-quality length walleyes during the spring. During summer, stock-quality length walleyes had significantly higher *Wr* than quality-preferred length walleyes.

Sauger proportional stock density (PSD) during 2002 generally decreased spring through autumn. Spring sauger PSD was significantly higher than autumn, but neither was significantly different from summer. In 2003, sauger PSD was similar spring through autumn. Walleye PSD exhibited contrasting trends during 2002 and 2003. Spring through autumn walleye PSD declined during 2002. Spring and summer walleye PSD's were significantly higher than autumn, but not from each other. Walleye PSD increased spring through autumn during 2003. Autumn walleye PSD was significantly higher than spring or summer, which were similar.

Walleyes and saugers collected during the 2003 gill netting activities for the Lewis and Clark Lake distribution study were also utilized for food habits evaluations. Food habits for saugers were conducted for the following length groups: 160-199 mm, 200-299 mm, 300-379 mm, and 380 mm and longer. Food habits for walleyes were conducted for the following length groups: 150-249 mm, 250-379 mm, 380-509 mm, and 510 mm and longer. Stomachs were examined until 10 stomachs containing food items were obtained for littoral and limnetic locations in both upper and lower zones per season, when possible. Food items were identified to the most practical taxon, counted, and dry weighed. Diet descriptions consisted of frequency of occurrence, percent composition by number, and percent composition by weight.

Both saugers and walleyes in Lewis and Clark Lake followed a fish to invertebrates to fish diet progression during the spring through autumn period. The sauger diet in spring was composed of 94% fishes by weight, mainly catfish and freshwater drum. During summer, invertebrates, mainly mayfly larvae, were 78% of the diet by weight and shiners were 22% of the diet by weight. Fishes, gizzard shad and freshwater drum, composed nearly 100% of the sauger diet by weight during autumn. The walleye diet during spring was comprised of over 75% fishes by weight, freshwater drum and river carpsuckers, and nearly 25% invertebrates by weight, primarily mayfly larvae. Benthic invertebrates, chiefly mayfly larvae, were the dominent food items by weight, followed by fish, mostly shiners, during summer. Fishes, mainly gizzard shad and freshwater drum, were nearly 100% of the walleye diet by weight during autumn.

Diet overlap between sauger and walleye in Lewis and Clark Lake during 2003 was high during summer and autumn. Mayfly larvae and shiners were important food items for both species during summer. Freshwater drum and gizzard shad were the dominant food items during autumn. Moderate Wr values during autumn could be the result of diet overlap between the two species.

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INTRODUCTION

Both walleyes *Sander vitreum* and saugers *Sander canadense* have inhabited Lewis and Clark Lake since its formation in 1956 (Walburg 1976). Sauger have historically been more abundant than walleye (Bailey and Allum 1962; Walburg 1976) and have remained so until recently (Wickstrom, 2005). Standardized fish population surveys on Lewis and Clark Lake, utilizing gill nets, have been conducted annually by Department of Game, Fish and Parks biologists since 1983. These surveys are conducted during late summer, which limits fish collection to a specific time of year. Consequently, little is known about fish distribution in Lewis and Clark Lake during other times of the year.

Creel surveys have been conducted on Lewis and Clark Lake during 1984, 1994, 1995, 2000, and 2001 (Stone 1985; Wickstrom 1995; Wickstrom 1996; Mestl et al. 2001; Wickstrom et al. 2002). Typically anglers harvest more walleyes than saugers, even though, until recently, fish population surveys show a higher abundance of saugers than walleyes (Wickstrom 2005). Thus, it seems that sauger may be under utilized by recreational anglers.

Bowen (1996) suggested that there should be specific reasons for doing fish species food habit studies. Results of recent fish population surveys on Lewis and Clark Lake have shown that walleye and sauger have low relative weights (Wr, Anderson 1980). During the 2005 fish population survey, stock-length (Anderson and Weithman 1978) walleye mean Wr was 81 and stock-length mean sauger Wr was 76 (Wickstrom, *in press*). Abundance of prey items, or prey item quality, could be a problem for walleye and sauger in Lewis and Clark Lake.

Extensive hybridization and introgression between sauger and walleye has been clearly documented in Lewis and Clark Lake. In a previous study, 24% of the fish contained alleles of the other species and 29% were misidentified by morphological examination (Billington et al. 2004). A much higher proportion of fish identified as walleye (39%) had sauger alleles in them than fish identified as sauger by morphology contained walleye alleles (9%). The ability to distinguish between saugers and walleyes may have implications for this study.

OBJECTIVES

The objectives of this study were to:

1. Describe movement of walleyes and saugers in the Missouri River between Ft. Randall Dam and Gavins Point Dam by December 2005.

2. Compare seasonal distribution of walleyes and saugers in Lewis and Clark Lake by December 2005.

3. Document seasonal food habits of walleyes and saugers in Lewis and Clark Lake by December 2005.

4. Provide information on sauger seasonal distribution and habitat use to anglers by December 2005, in an attempt to improve angler harvest and utilization of sauger in the fishery.

STUDY AREA

Lewis and Clark Lake, located in southeastern South Dakota, is the lower-most mainstem Missouri River reservoir. It was formed by the closure of Gavins Point Dam near Yankton, South Dakota and covers approximately 10,500 ha. A reach of unchannelized Missouri River, approximately 60 km long, extends upstream from Lewis and Clark Lake to Ft. Randall Dam. Lewis and Clark Lake has a maximum depth of 16.7 m and a mean depth of 5.0 m. The shoreline is nearly straight, except for small, shallow bays at the mouths of intermittent tributary streams. Vegetation in the reservoir is scarce. Lewis and Clark Lake does not thermally stratify due to its relatively shallow depth. For sampling purposes, Lewis and Clark Lake was divided into two zones (Figure 1). The upper zone, which extends from river kilometer (rk) 1318 to rk 1329, consists of a large expanse of shallow (2-4 m) water that is commonly turbid from frequent winds. The lower zone, which extends from rk 1305 to rk 1318, is deeper (5-12 m), clearer and less disrupted by wind than the upper zone.

METHODS

SITE SELECTION

Sampling sites were defined by superimposing a 600 m x 600 m grid over a Lewis and Clark Lake map. A stratified-random sampling design was used to establish sampling locations by selecting three limnetic (offshore) and three littoral (near-shore) cells per reservoir zone. Littoral cells contained shoreline and limnetic cells lacked shoreline. Once a cell was selected for sampling, no adjacent cell could be selected during the same season in order to avoid the influence of a sampled cell on an adjacent cell. No cell could be selected more than once a year so as to avoid sampling a depleted cell.

FIELD COLLECTION OF FISHES

Walleyes and saugers were collected for tagging with gill nets, trap nets, and by pulsed, DC electrofishing. Gill nets, 50.8 mm bar measure mesh, were fished during April and May 2002 in the Missouri River upstream of Lewis and Clark Lake, mainly in Ft. Randall Dam tailwater. Gill nets were lifted approximately each hour for fish removal and tagging. Trap nets were fished April and early June in Lewis and Clark Lake between rk 1311 and rk 1318 and along the face of Gavins Point Dam. Trap nets were pulled daily for fish removal and tagging. Electrofishing (180 v, 6-8 a, and 60 pps) was done during April and May at Ft. Randall Dam tailwater, in the Missouri River from rk 1403 to 1408 and rk 1340 to 1347, in Lewis and Clark Lake from rk 1313 to 1322. Walleyes and saugers were measured and 300 mm and longer fish had dangler tags attached as described by Riis (1983). Tagged fish were released in the vicinity of where they were caught.

Walleyes and saugers were collected from Lewis and Clark Lake using 91.4 m by 1.8 m experimental gill nets with 15.2 m panels of 12.7 mm, 19.1 mm, 25.4 mm, 31.8 mm, 38.1 mm, and 50.8 mm bar measure meshes. Three gill nets were fished in each of three littoral and three limnetic cells in two reservoir zones during three seasons. Appendix 1 and 2 provide universal transverse mercator coordinates of gill nets set in Lewis and Clark Lake. A total of 36 gill nets were fished overnight (approximately 20 h) each month during May, July, and September (spring, summer, and autumn) 2002 and 2003. Surface water temperature, conductivity, and secchi disc readings were measured during each period of time gill nets were being fished.

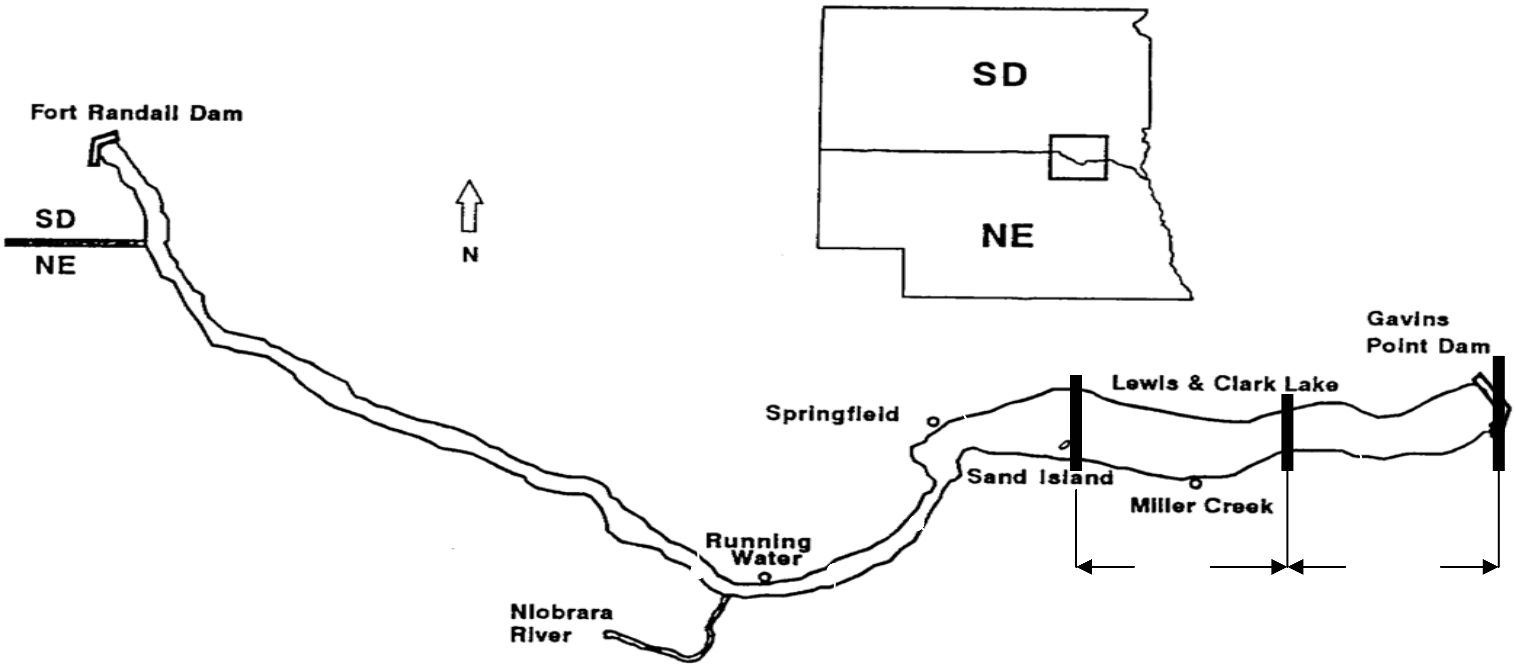

Figure 1. Lewis and Clark Lake study area showing the upper sampling zone (river kilometer 1318 to 1329), the lower sampling zone (river kilometer 1305 to 1318), and the unchannelized Missouri River upstream of the reservoir.

DATA COLLECTION FROM SAMPLED FISHES

Tags were recovered from walleyes and saugers from gill netting efforts and from angler returns. Postage-free envelopes were provided to bait shops, marina, state parks, and Game, Fish and Parks personnel to facilitate angler returns. The back of the envelope contained a brief questionnaire requesting pertinent catch information from the angler. Follow-up contacts were made for anglers providing incomplete catch data for tagged fish.

All fishes sampled with gill nets for the fish distribution portion of the study were counted, measured, and weighed. During 2003, walleyes and saugers were stored on ice to slow digestion during completion of gill netting and data collection activities. Digestive tracts were removed in the field and preserved in normalin. Pyloric caeca number was used to differentiate walleye from sauger when identification from external features was uncertain.

Age-1 and older walleyes and saugers collected with gill nets in Lewis and Clark Lake during 2003 were utilized for food habit determinations. Walleyes used for food habit study were divided into four groups: 150-249 mm, 250-379 mm, 380-509 mm, and 510 mm and longer. Saugers used for food habit study were also divided into four groups: 160-199 mm, 200-299 mm, 300-379 mm, and 380 mm and longer. Fish stomachs were examined until 10 stomachs containing food were obtained from a species length group or until the supply of stomachs was depleted.

In the lab, stomachs were removed from the digestive tract and food items extracted. Food items were identified to a reasonable taxon (Bowen 1996) and counted. Partially digested food items were identified based upon structures resistant to digestion. Food items digested beyond recognition were placed into an unidentifiable category. Empty stomachs were recorded as such. All food items from a fish were sorted by taxon, placed on aluminum weighing pans and dried for approximately 20 hours at 60 C. Dry weights of each taxon of food items were obtained for each fish examined.

DATA PROCESSING AND ANALYSIS

Tagging data and tag return data, from both angler caught fish and gill netted fish, were entered into a personal computer. Return rate, incremental exploitation, and distance moved were calculated for walleye and sauger. Individual tagged fish reports were provided to anglers who supplied catch data.

Relative abundance of walleye and sauger, caught during fish distribution gill netting, was expressed as mean catch per unit effort (CPUE). Catch-per-unit-effort values were transformed to Log_{10} to better approximate normality. Walleye and sauger transformed CPUE values and mean total lengths were compared between littoral and limnetic cells, between zones, and among seasons using an analysis of variance procedure (SYSTAT 1998a). When significant p-values for interactions were obtained, pairwise comparisons of the involved factors were made to facilitate interpretation of the results. Statistical analysis was completed using Systat Version 8.0 (SYSTAT 1998b) for CPUE data and mean length data. The critical value for statistical significance was 0.05. Yearly CPUE and mean total length values were pooled when no significant differences were identified.

Proportional stock density (PSD, Anderson and Weithman 1978) and relative stock density (RSD) values were calculated for walleye and sauger collected with gill nets. Values of PSD and RSD were based on length categories proposed by Gablehouse (1984). A Chi-square procedure (SYSTAT 1998a) was used to detect significant PSD and RSD value differences between littoral and limnetic cells, reservoir zones, and among seasons. Statistical analysis of PSD and RSD values was completed using Systat Version 8.0 (SYSTAT 1998b). The critical value for statistical significance was 0.05. Size structure values were used to compare walleye and sauger distribution within Lewis and Clark Lake.

Relative weight (*Wr*, Anderson 1980) values were calculated for walleyes and saugers and tested for normality and homogeneity of variances with a two-sample Kolmogorov-Smirnov (SYSTAT 1998a) procedure prior to statistical testing. Lewis and Clark Lake walleye and sauger *Wr* values were compared between littoral and limnetic cells, reservoir zones, and among seasons by length groups as proposed by Gablehouse (1984). An analysis of variance procedure using Systat Version 8.0 (SYSTAT 1998b) was used to test for *Wr* statistical differences with the critical value of 0.05. Yearly *Wr* values were pooled when no significant differences were detected.

Walleye and sauger diets were quantified from stomachs containing food items using three diet measures for each taxon consumed: frequency of occurrence, percent of total number of food items consumed, and percent of total dry weight. The three diet measures were computed by length group and strata, by length group and season, and by season with length groups and strata combined. Fish diet quantification by percent composition by weight suggests the relative importance of individual food types in the nutrition of the fish. Thus, discussion will focus on food item importance based on their percent composition by weight.

Diet overlap between sauger and walleye was measured using the Schoener index (Schoener 1971). Food habits data for all length categories were combined by season. Dry weights of each prey taxon were used to calculate Schoener's index. Because of the incidence of unidentified fishes, Schoener's index was calculated with unidentified fish included and with unidentified fish excluded.

RESULTS AND DISCUSSION

SAUGER AND WALLEYE EXPLOITATION AND MOVEMENT

A total of 155 saugers were tagged during April-June, 2002 (Table 1). During the remainder of the first year after being tagged, 11 saugers were caught and 5 were harvested. Most saugers were tagged at Lewis and Clark Lake, followed by the Missouri River and Ft. Randall Dam tailwater (Table 2). The majority of saugers were recaptured at Lewis and Clark Lake, followed by Ft. Randall Dam tailwater and the Missouri River (Table 3). Most saugers tagged were from 300-mm to 349-mm total length (Table 4). The highest first-year catch rate for saugers came from the 400-mm to 449-mm length group. Angler exploitation, from time of tagging to the end of the first calendar year, was approximately three percent (Table 1).

Over 38% of the tagged saugers were recaptured in the same vicinity as where they were tagged (Table 5). Fourteen saugers traveled downstream after being tagged and only four traveled upstream. The farthest a sauger traveled downstream was 21 river km and upstream was 43 river km. One sauger passed through Gavins Point Dam and was recaptured in the tailwater. Other studies have also reported saugers passing through Gavins Point Dam (Nelson 1969; Riis et al. 1993; Wickstrom 1995).

A total of 834 walleyes were tagged during April-June 2002. During the remainder of 2002, 122 (14.6%) of the tagged fish were caught and 113 (13.5%) were harvested by anglers (Table 1). Most walleyes were tagged at Ft. Randall Dam tailwater, followed by Lewis and Clark Lake and the Missouri River (Table 2). The majority of walleyes were recaptured at Ft. Randall Dam tailwater, followed by Lewis and Clark Lake and the Missouri River (Table 3). Eight walleyes passed through Gavins Point Dam and were recaptured in the tailwater. Most walleyes tagged were from 400-mm to 449-mm total length (Table 4). The highest first-year return rate came from the 500-mm to 549-mm length group.

Table 1. Summary of tagging and recapture data for saugers and walleyes in the Missouri River between Ft. Randall Dam and Gavins Point Dam.

		Number and percentage (cumulative) of tagged fish reported by anglers per calendar year							
		Sauger							
	Number	2002		2003		2004		2005	
Fate	tagged	No.	%	No.	%	No.	%	No.	%
Caught	155	11	7.1	11	14.2	5	17.4	1	18.1
Harvested	155	5	3.2	8	8.4	5	11.6	1	12.2
Walleye									
Caught	834	122	14.6	59	21.7	15	23.5	2	23.7
Harvested	834	113	13.5	55	20.1	12	21.5	1	21.6
Combined									
Caught	989	133	13.4	70	20.5	20	22.5	3	22.8
Harvested	989	118	11.9	68	18.8	17	20.5	2	20.7

Table 2. Number of sauger and walleye tagged, by area, during 2002 (RK = river kilometer).

	Lewis and Clark Lake	Missouri River	Ft. Randall Tailwater
Species	RK 1304-1332	RK 1334-1408	RK 1409-1416
Sauger	100	37	18
Walleye	238	95	501
Total	338	132	519

Table 3. Number of sauger and walleye recaptured, by area, during 2002-2005 (RK = river kilometer).

	Gavins Pt. Tailwater	Lewis and Clark Lake	Missouri River	Ft Randall Tailwater
	RK 1303-below	RK 1304-1332	RK 1333-1408	RK 1409-1416
Species	No. recaptured	No. recaptured	No. recaptured	No. recaptured
Sauger	1	23	2	3
Walleye	8	74	38	85
Total	9	97	4	88

Table 4. Tagging and recapture statistics for sauger and walleye in the Missouri River between Ft. Randall Dam and Gavins Point Dam during 2002.

Length Group (mm)	Number tagged	Number caught	Number kept	Number released	Percent caught	Percent of those caught: Kept	Percent of those caught: Released
Sauger							
300-349	51	2	1	1	3.9	50.0	50.0
350-399	43	5	1	4	11.6	20.0	80.0
400-449	30	4	3	1	13.3	75.0	25.0
450-499	15	0	0	0	0	-	-
500-549	13	0	0	0	0	-	-
550-599	3	0	0	0	0	-	-
600+	0	0	0	0	0	-	-
Total	155	11	5	6	7.1	45.5	54.5
Walleye							
300-349	62	1	1	0	1.6	100.0	0
350-399	193	27	18	9	14.0	67.7	33.3
400-449	253	44	44	0	17.4	100.0	0
450-499	223	32	32	0	14.3	100.0	0
500-549	77	14	14	0	18.2	100.0	0
550-599	15	4	4	0	26.7	100.0	0
600+	11	0	0	0	-	-	-
Total	834	122	113	9	14.6	92.6	7.4

Table 5. Number of tagged saugers and walleyes recaptured at various distances from the original tagging site in the Missouri River between Ft. Randall Dam and Gavins Point Dam.

	Downstream (river kilometers)					Upstream (river kilometers)			
Species	50+	32-49	17-31	1-16	0	1-16	17-31	32-49	50+
Sauger	0	0	1	13	11	2	0	2	0
Walleye	20	3	4	56	99	8	6	2	7
Total	20	3	5	69	110	10	6	4	7

Over 48% of the tagged walleyes were recaptured in the same vicinity as where they were tagged (Table 5**)**. Other studies have also shown little movement after tagging (Rawson 1956; Ragan 1974; Riis 1983; Riis et al 1993, Wickstrom 1995; Wickstrom 1996). A total of 83 walleyes moved downstream compared to 23 walleyes that moved upstream after being tagged. However, most of the walleyes were tagged at Ft. Randall Dam tailwater where upstream travel was stopped by Ft. Randall Dam. Eight walleyes traveled greater than 80 river km downstream, while five walleyes traveled greater than 80 river km upstream. The farthest distance a walleye traveled downstream was 108 river km and upstream was 103 river km.

First-year return rates for walleye and sauger in the Missouri River between Ft. Randall Dam and Gavins Point Dam have varied considerably over time. During 2002, the first-year return rate for walleye was nearly 15% compared to just over 7% for sauger. Previous studies have shown first-year walleye catch rates of 6% to 31% for the Missouri River below Ft. Randall Dam (Riis et al. 1993; Wickstrom 1995; Wickstrom 1996). First-year sauger catch rates in the same Missouri River reach ranged from 4% to 22% in past studies (Riis et al. 1993; Wickstrom 1995; Wickstrom 1996).

Distances traveled by walleye and sauger from tagging location to recapture location was also variable. During the current study, over 20% of the tagged walleyes traveled farther than 16 river km from time of tagging until their recapture, but only 10% of the saugers traveled farther than 16 river km. In a previous study (Riis et al. 1993) of movement in the Missouri River between Ft. Randall Dam and Gavins Point Dam, the percentage of walleyes that traveled farther than 16 river km from the tagging location ranged from 14% to 48%. In the same study, the percentage of saugers that traveled farther than 16 river km ranged from 31% to 40%. During 2002, over 48% of the tagged walleyes and nearly 39% of the tagged saugers were recaptured in the vicinity of the tagging location. In previous studies (Riis et al. 1993; Wickstrom 1995; Wickstrom 1996), from nearly 14% to over 68% of the tagged walleyes and from 13% to over 50% of the tagged saugers were recaptured near the tagging location.

In 2002, nearly all of the tagged walleyes caught by anglers were kept. The only fish released were in the 350-399 mm category. Lott et al. (2002) reported that harvest of walleyes in Lake Oahe, SD during 2001 was indiscriminate, there was no change in harvest rates for fish of increasing length. Sauger recaptures in 2002 showed a pattern of anglers harvesting a higher percentage of their catch with increasing fish length. The highest percentage of saugers harvested were the largest saugers caught. Additionally, a year-round, 380-mm minimum length limit regulation for harvest of walleye and sauger exists in the majority of the study area. Only at Ft. Randall Dam tailwater are walleye and sauger shorter than 380 mm legal to keep, but only during July and August. Thus, the minimum length limit may have prevented anglers from keeping more walleyes and saugers from the smaller size groups during the study.

Walleye and sauger catchability during 2002, as indexed by the percentage of tagged walleyes from each 50-mm length group caught by anglers, increased with increasing fish length (Table 4). Shortage of suitable prey items could be one reason for increased catchability at larger sizes. Relative weights for all length categories of walleye and sauger were consistent but somewhat low, ranging in the upper 70’s to low 80’s in 2002 (Wickstrom 2003). Abundance of prey fishes in seine hauls during 2002 was below the long-term average (Wickstrom 2005).

SEASONAL DISTRIBUTION OF SAUGER AND WALLEYE

Catch Per Unit Effort

Catch per unit effort data, from gill net catches for sauger and walleye, were analyzed separately by species (Table 6). For sauger, two significant, two-factor interactions (season*zone and zone*location) were obtained from the analysis of variance procedure (Appendix 3). Because of significant, two-factor interactions, main effects with significant p-values were not valid. To interpret the results, pairwise comparisons were made of zone and location within a season (Appendix 4). For the season*zone interaction, sauger CPUE was significantly higher in the lower zone than the upper zone during the spring and summer ($p=0.016$, $p<0.000$). But during autumn, sauger CPUE's in the lower and upper zones were similar ($p=0.115$). For the zone*location interaction, sauger CPUE's in the upper zone for the littoral and limnetic locations were similar ($p=0.752$). For the lower zone, sauger CPUE at the limnetic location was significantly higher than the littoral location ($p<0.000$). Thus, in order to catch sauger with minimal effort in Lewis and Clark Lake, sampling should take place in limnetic areas in the lower zone, except during autumn when limnetic areas in either zone would suffice. Hiltner (1983) found that saugers were more abundant than walleyes in the upper-lake region of Lake Sakakawea, North Dakota, the most turbid area of the reservoir.

Table 6. Mean gill net catch per unit effort (standard error) of sauger and walleye for littoral and limnetic areas in the upper and lower zones of Lewis and Clark Lake during spring, summer, and autumn of 2002 and 2003.

		Sauger					
		Spring		Summer		Autumn	
Year	Zone	Limnetic	Littoral	Limnetic	Littoral	Limnetic	Littoral
2002	Upper	2.0 (0.3)	2.6 (0.7)	6.4 (0.7)	5.4 (0.9)	7.1 (0.7)	4.7 (0.6)
2002	Lower	5.8 (1.0)	2.1 (0.7)	2.4 (0.6)	1.9 (0.6)	14.6 (2.2)	4.4 (1.2)
2003	Upper	2.2 (0.6)	3.2 (1.9)	1.2 (0.5)	2.2 (1.5)	4.4 (0.8)	5.0 (1.2)
2003	Lower	4.2 (0.6)	3.0 (0.9)	8.2 (2.3)	2.4 (0.4)	10.3 (2.0)	3.9 (1.2)
		Walleye					
2002	Upper	6.4 (0.8)	4.1 (0.4)	7.8 (1.4)	3.4 (1.0)	8.3 (1.3)	10.4 (2.4)
2002	Lower	3.4 (0.7)	7.2 (1.6)	5.2 (1.2)	4.1 (0.4)	6.8 (0.9)	7.0 (1.5)
2003	Upper	5.4 (1.0)	4.7 (1.1)	4.2 (0.7)	4.1 (1.0)	8.9 (1.5)	8.1 (1.6)
2003	Lower	4.8 (1.1)	8.1 (0.9)	3.3 (1.2)	3.2 (0.7)	14.2 (1.9)	13.4 (3.2)

For walleye CPUE data, a significant, three-factor interaction (season*zone*location) was obtained from the analysis of variance procedure (Appendix 5). Because of the three-factor interaction, main effects with significant p-values were not valid. To interpret the results, pairwise comparisons were made between zones within a location and season, and between locations within a zone and season (Appendix 6). Spring walleye CPUE's in the lower zone were significantly higher in littoral than limnetic locations ($p=0.005$, $p=0.018$) and in the upper zone were higher in limnetic than littoral locations ($p=0.055$). Summer CPUE's in the upper zone were significantly higher in limnetic than littoral locations ($p=0.027$, $p=0.026$). During autumn, CPUE's were similar for zones and locations. Blackwell and Brown (2000) found that walleyes in Lake Kampeska, South Dakota were in limnetic locations during spring, but found

no difference in distribution during summer and autumn. At Enemy Swim Lake, no difference was found in walleye distribution during spring, summer, or autumn (Blackwell and brown 2000). Nelson and Walburg (1976) stated that 66% of adult walleye were caught in the lower half of Missouri Reservoirs in South Dakota. Consistently high walleye catches came from a shallow water site in lower Lewis and Clark Lake during July, August, and September (Wickstrom 2000). Dieterman and Berry (1995) speculated that higher walleye catch rates in the Big Sioux River above Sioux Falls, South Dakota reflected worse habitat conditions, primarily sedimentation, in the lower river than the upper river.
For this study, the best time and place to catch walleyes at Lewis and Clark Lake was anywhere during autumn.

Mean Total Length

Mean total lengths for sauger caught in gill nets ranged from 279.8 mm to 411.9 mm (Table 7). A significant, three-factor interaction (season*zone*location) was obtained in the analysis of variance procedure (Appendix 7). Appendix 8 provides pairwise comparisons of sauger mean total length by zone and location within seasons. Significantly larger sauger were found in the spring in littoral than in limnetic locations of the upper zone (p=0.018) and in limnetic than in littoral locations of the lower zone (p=0.058). In the summer, larger sauger were found in limnetic than in littoral locations in the upper zone (p=0.002, p=0.023). During autumn, larger sauger were found in limnetic than in littoral locations of both the upper reservoir (p=0.000) and lower reservoir (p=0.010). Only during autumn was larger sauger consistently found away from shore in limnetic locations in both zones of the reservoir.

Table 7. Mean total lengths (mm; standard error) of sauger and walleye for limnetic and littoral locations in the upper and lower zones of Lewis and Clark Lake during spring, summer, and autumn of 2002 and 2003.

		Sauger					
		Spring		Summer		Autumn	
Year	Zone	Limnetic	Littoral	Limnetic	Littoral	Limnetic	Littoral
2002	Upper	297.3 (43.39)	350.7 (41.21)	385.7 (28.09)	337.5 (28.66)	362.1 (28.98)	339.6 (27.49)
2002	Lower	369.1 (33.45)	342.5 (40.48)	411.9 (25.55)	369.4 (42.18)	345.2 (37.25)	390.9 (32.06)
2003	Upper	332.8 (29.73)	382.5 (35.97)	368.7 (31.53)	341.9 (27.84)	344.2 (28.56)	337.1 (26.89)
2003	Lower	327.7 (32.51)	362.5 (42.64)	323.4 (47.00)	325.1 (39.60)	301.1 (37.48)	279.8 (41.28)
		Walleye					
2002	Upper	345.8 (17.27)	376.6 (26.71)	428.8 (27.06)	331.7 (35.05)	413.5 (27.40)	309.5 (34.57)
2002	Lower	383.5 (37.83)	378.4 (26.98)	386.0 (38.83)	279.6 (37.95)	347.9 (42.34	285.0 (46.70)
2003	Upper	371.5 (23.72)	350.5 (22.84)	355.4 (18.24)	389.8 (28.73)	340.9 (34.87)	286.0 (40.40)
2003	Lower	353.1 (26.85)	352.8 (29.87)	338.2 (31.32)	302.3 (35.92)	350.7 (32.68)	289.0 (44.27)

Mean total lengths for walleye caught in gill nets ranged from 279.6 mm to 413.5 mm (Table 7). A significant three-factor interaction (season*zone*location) was obtained in the analysis of variance procedure (Appendix 9). Appendix 10 provides pairwise comparisons of walleye mean total length by zone and location within seasons. No significant difference of walleye length was detected between zones or locations during spring. Larger walleyes were found in limnetic than in littoral locations of the upper zone during the summer (p=0.000). During autumn, larger walleyes were found in littoral than in limnetic locations of the upper zone (p=0.000) and in limnetic than in littoral locations of the lower zone (p=0.000).

<u>Mean Relative Weight</u>

Mean *Wr* values for sauger caught in Lewis and Clark Lake during 2002 and 2003 ranged from 73 to 90 (Table 8). No differences in mean *Wr* were detected among seasons, zones, locations, or groups because of the significant four-factor interaction (season*zone*location*group) present (Appendix 11). Snedecor and Cochran (1967) stated that three-factor interactions are rather difficult to grasp. A four-factor interaction should therefore be impossible to interpret. Additionally, Systat (SPSS 1998) does not process multiple comparisons for more than three factors.

Mean *Wr* values for walleye caught in Lewis and Clark Lake during 2002 and 2003 ranged from 77 to 92 (Table 9). Two significant, two-way interactions (season*group, zone*group) were present in the analysis of variance results (Appendix 12). During spring, quality-preferred length walleye had significantly higher mean *Wr* than stock-quality length walleye (p=0.005), but not preferred-length fish (Appendix 13). During summer, stock-quality length walleye had significantly higher mean *Wr* than quality-preferred length walleye (p=0.037), but not preferred-length fish. No significant differences were detected for the various length groups between seasons or zones.

Table 8. Mean relative weights (standard error) of sauger by length category, for limnetic and littoral locations, and the upper and lower zones of Lewis and Clark Lake during spring, summer, and autumn of 2002 and 2003. N is the number of stock-length fish.

Strata	Stock-quality	Quality-preferred	Preferred	N
		Spring 2002		
Upper zone	90 (1.9)	83 (1.4)	79 (1.7)	29
Lower zone	87 (2.6)	86 (1.0)	80 (1.1)	67
Littoral	86 (3.1)	84 (1.2)	81 (1.3)	35
Limnetic	88 (2.9)	86 (1.0)	78 (1.4)	61
Combined	87 (2.2)	85 (0.8)	80 0.9)	96
		Summer 2002		
Upper zone	80 (1.2)	76 (1.1)	79 (1.5)	37
Lower zone	83 (1.0)	79 (0.7)	77 (1.0)	102
Littoral	82 (0.9)	80 0.7)	79 (1.6)	65
Limnetic	84 (1.5)	76 (1.0)	77 (1.0)	74
Combined	82 (0.8)	79 (0.7)	77 (0.8)	139
		Autumn 2002		
Upper zone	80 (1.0)	78 (0.9)	77 (0.8)	100
Lower zone	78 (0.6)	79 (0.6)	79 (0.7)	162
Limnetic	80 (0.9)	79 (0.9)	78 (1.0)	78
Littoral	78 (0.6)	79 (0.6)	78 (0.6)	187
Combined	78 (0.5)	79 (0.5)	78 (0.5)	262
		Spring 2003		
Upper zone	84 (4.0)	76 (1.0)	76 (1.1)	39
Lower zone	77 (1.2)	78 (0.7)	81 (1.4)	77
Littoral	81 (2.5)	77 (0.8)	80 (1.5)	56
Limnetic	77 (2.1)	78 (0.9)	80 (1.3)	60
Combined	79 (1.7)	78 (0.6)	80 (1.0)	116
		Summer 2003		
Upper zone	79 (0.4)	73 (1.9)	73 (1.2)	27
Lower zone	74 (1.0)	73 (0.7)	73 (0.8)	96
Littoral	76 (1.7)	76 (1.3)	74 (0.9)	37
Limnetic	74 (1.1)	73 (0.7)	73 (0.9)	86
Combined	75 (1.0)	73 (0.6)	73 (0.7)	123
		Autumn 2003		
Upper zone	83 (1.1)	81 (1.1)	79 (0.9)	70
Lower zone	84 (1.4)	81 (0.9)	80 (0.6)	100
Littoral	83 (1.2)	81 (0.9)	78 (1.1)	58
Limnetic	85 (1.9)	81 (0.9)	79 (0.6)	112
Combined	84 (1.0)	81 (0.7)	79 (0.5)	170

Table 9. Mean relative weights (standard error) of walleye by length category, for limnetic and littoral locations, and the upper and lower zones of Lewis and Clark Lake during spring, summer, and autumn of 2002 and 2003. N is the number of stock-length fish.

Strata	Stock-quality	Quality-preferred	Preferred	N
		Spring 2002		
Upper zone	87 (1.2)	87 (1.0)	85 (1.5)	72
Lower zone	89 (1.0)	89 (0.9)	88 (3.3)	61
Littoral	87 (1.1)	87 (0.9)	88 (3.3)	69
Limnetic	88 (1.1)	89 (1.0)	85 (1.5)	64
Combined	88 (0.8)	88 (0.7)	87 (2.5)	133
		Summer 2002		
Upper zone	81 (1.3)	78 (2.1)	82 (0.6)	86
Lower zone	85 (1.6)	83 (1.0)	82 (2.0)	58
Littoral	86 (1.9)	83 (1.4)	84 (1.4)	47
Limnetic	82 (1.2)	82 (1.3)	81 (0.6)	97
Combined	83 (1.1)	82 (0.9)	82 (0.6)	144
		Autumn 2002		
Upper zone	82 (0.7)	82 (0.5)	79 (1.3)	152
Lower zone	81 (0.6)	81 (1.4)	85 (1.8)	82
Limnetic	81 (0.6)	82 (0.6)	79 (1.4)	129
Littoral	81 (0.7)	82 (0.8)	86 (1.1)	105
Combined	81 (0.5)	82 (0.5)	81 (1.2)	234
		Spring 2003		
Upper zone	84 (0.9)	85 (0.9)	86 (2.3)	84
Lower zone	84 (0.6)	89 (1.2)	91 (2.9)	107
Littoral	86 (0.6)	87 (1.0)	92 (2.9)	108
Limnetic	83 (0.8)	87 (1.2)	86 (2.2)	83
Combined	84 (0.5)	87 (0.8)	88 (1.9)	191
		Summer 2003		
Upper zone	83 (1.2)	79 (1.0)	80 (1.9)	54
Lower zone	81 (0.8)	81 (1.3)	80 (1.8)	48
Littoral	82 (0.9)	80 (1.2)	77 (2.4)	41
Limnetic	82 (1.0)	80 (1.1)	81 (1.7)	61
Combined	82 (0.7)	80 (0.8)	80 (1.5)	102
		Autumn 2003		
Upper zone	84 (0.8)	83 (0.9)	79 (1.7)	110
Lower zone	86 (0.7)	84 (0.5)	85 (2.1)	179
Littoral	85 (0.8)	84 (0.6)	84 (2.5)	116
Limnetic	85 (0.7)	83 (0.6)	80 (1.7)	173
Combined	85 (0.5)	83 (0.4)	82 (1.4)	289

Stock Structure Indices

Sauger PSD values were mostly consistent within a season and seasonal values decreased as the seasons progressed during 2002 (Table 10). The 2002 spring combined PSD value was significantly higher than the autumn combined value. No significant difference was observed for 2003 seasonal combined PSD values. Sauger PSD for limnetic locations was significantly higher than for littoral locations in summer of 2002 and autumn of 2003. The highest number of stock-length sauger sampled was during autumn for both 2002 and 2003.

Sauger RSD-P values were significantly higher for littoral locations than limnetic locations during spring of 2002 and summer of 2003. Sauger RSD-P values were significantly higher for limnetic locations than littoral locations during summer 2002 and autumn 2003. The sauger PSD-P value was significantly higher in the upper zone than the lower zone only during the summer of 2003. The combined RSD-P value was significantly higher during autumn than spring or summer in 2003.

Sauger RSD-M values ranged from zero to 10 during spring through autumn in 2002 and zero to 11 during spring through autumn 2003. Highest RSD-M values were obtained in the spring of 2002 and summer of 2003, 10 and 11, respectively. The combined sauger RSD-M value for spring 2002 was significantly higher than summer or autumn. Summer 2003 had significantly a higher combined RSD-M value than autumn but not spring.

Walleye PSD values were generally higher in the upper zone than the lower zone in 2002 and 2003 (Table 11). Significantly higher PSD values were observed in the upper zone than the lower zone during summer and autumn of 2002 and spring and summer of 2003. The combined PSD value was significantly lower in autumn than in spring or summer of 2002. Combined PSD value was significantly higher in autumn than in spring or summer of 2003. The highest number of stock-length walleye sampled was during autumn for both 2002 and 2003.

Differences in walleye RSD-P values, between zones and littoral and limnetic locations, were detected only during the summer of 2003. Walleye RSD-P values were similar, between zones and littoral and limnetic locations, for spring through autumn of 2002 and spring and autumn of 2003. Combined RSD-P values were similar spring through autumn for both 2002 and 2003.

Walleye RSD-M values ranged from zero to 2 during spring through autumn 2002 and zero to 1 during spring through autumn 2003. During the summer of both 2002 and 2003 no memorable-length walleye was sampled. No significant difference of combined RSD-M values was detected among spring, summer, or autumn during 2002 or 2003.

Table 10. Proportional stock density (PSD) and relative stock density-preferred and memorable (RSD-P, RSD-M) of sauger for littoral and limnetic locations, and the upper and lower zones of Lewis and Clark Lake during spring, summer, and autumn of 2002 and 2003. Seasonal PSD, RSD-P, and RSD-M values for upper and lower zones and littoral and limnetic locations with an asterisk are significantly different (p=0.05). Combined PSD, RSD-P, and RSD-M values, within the same year, that have no letter in common are significantly different (p=0.05). N equals the number of stock-length fish.

Strata	PSD	RSD-P	RSD-M	N
		Spring 2002		
Upper zone	87	48	10	31
Lower zone	77	30	3	68
Littoral	86	51*	3	37
Limnetic	77	24	3	62
Combined	81a	35a	5a	99
		Summer 2002		
Upper zone	73	51	3	37
Lower zone	77	39	2	103
Littoral	68*	29*	0	65
Limnetic	82	53	2	75
Combined	76ab	42a	2b	140
		Autumn 2002		
Upper zone	73	45	3	100
Lower zone	65	38	1	162
Littoral	65	32	0	78
Limnetic	69	45	2	184
Combined	68b	41a	2b	262
		Spring 2003		
Upper zone	82	44	3	39
Lower zone	84	43	5	75
Littoral	79	43	5	56
Limnetic	88	43	3	58
Combined	83a	43a	4ab	114
		Summer 2003		
Upper zone	93	74*	11	27
Lower zone	88	34	6	96
Littoral	92	57*	11	37
Limnetic	87	37	6	86
Combined	89a	43a	7a	123
		Autumn 2003		
Upper zone	89	64	3	70
Lower zone	86	47	0	100
Littoral	74*	40*	0	58
Limnetic	94	62	2	112
Combined	87a	54b	1b	170

Table 11. Proportional stock density (PSD) and relative stock density-preferred and memorable (RSD-P, RSD-M) of walleye for littoral and limnetic locations, and the upper and lower zones of Lewis and Clark Lake during spring, summer, and autumn of 2002 and 2003. Seasonal PSD, RSD-P, and RSD-M values for upper and lower zones and littoral and limnetic locations with an asterisk are significantly different (p=0.05). Combined PSD, RSD-P, and RSD-M values, within the same year, that have no letter in common are significantly different (p=0.05). N equals the number of stock-length fish.

Strata	PSD	RSD-P	RSD-M	N
		Spring 2002		
Upper zone	58	3	1	72
Lower zone	61	10	2	61
Littoral	65	9	1	69
Limnetic	53	3	2	64
Combined	59a	6a	2a	133
		Summer 2002		
Upper zone	80*	2	0	86
Lower zone	59	9	0	58
Littoral	64	9	0	47
Limnetic	75	4	0	97
Combined	72a	6a	0a	144
		Autumn 2002		
Upper zone	59*	7	1	152
Lower zone	28	9	1	82
Littoral	50	10	2	129
Limnetic	45	5	0	105
Combined	48b	8a	1a	234
		Spring 2003		
Upper zone	56*	11	0	84
Lower zone	28	7	1	107
Littoral	38	6	1	108
Limnetic	43	12	0	83
Combined	40a	8a	1a	191
		Summer 2003		
Upper zone	46*	20*	0	54
Lower zone	23	6	0	48
Littoral	24	5*	0	41
Limnetic	41	20	0	61
Combined	34a	14a	0a	102
		Autumn 2003		
Upper zone	53	14	1	110
Lower zone	54	6	0	179
Littoral	52	9	1	116
Limnetic	55	9	0	173
Combined	54b	9a	0a	289

SAUGER FOOD HABITS

A total of 345 sauger stomachs were examined and 165 (47.8%) were found to be empty. Thus, food habits analysis was performed for 180 saugers.

Fishes were consumed by all size classes of sauger during all seasons sampled and comprised over 99% of the diet by weight during autumn (Table 12). Fishes comprised a large portion, by weight, of the diet for mid-size (300-379 mm) and large (>379 mm) saugers, spring through autumn. Catfish, presumably channel catfish *Ictalurus punctatus*, was the dominant food item, by weight, for all sizes of sauger during spring. Channel catfish were common in Lewis and Clark Lake, but flathead catfish *Pylodictus olivaris* were also present when sampling occurred (Wickstrom 2004). Freshwater drum *Aplodinotus grunniens* and gizzard shad *Dorosoma cepedianum* were dominant food items, by weight, for all sizes of sauger during autumn. Unkenholz et al. (1982) found that gizzard shad was an important food item for saugers during autumn. Vanicek (1964) reported that age-0 gizzard shad was the most important food item for saugers in Lewis and Clark Lake.

Benthic invertebrates were important food items during spring and summer. Small saugers (200-299 mm) ate chiefly mayfly larvae (*Hexagenia sp*.), by weight, during the spring and summer. Mid-size and large saugers ate mostly mayfly larvae, by weight, during summer. Other studies found that mayfly larvae were frequently utilized by saugers during the spring (Unkenholz et al. 1982) and insect larvae were consumed during early summer (Vanicek 1964).

A high incidence of unidentified fishes was obtained in the analysis of food items contained in sauger stomachs, especially during autumn. This is likely the result of earlier feeding and decomposition of food items while the saugers were being held in gill nets when the water temperature was over 20 ^{0}C (Appendix 14). The lowest incidence of unidentified fishes in the diet occurred during spring when the water temperature was the lowest recorded.

It is notable that shiners (*Notropis spp*.), commonly found in Lewis and Clark Lake (Wickstrom 2003), were represented in the sauger diet at low incidences during spring and summer, and absent during autumn. Shiners likely represent a considerable portion of the unidentified fishes due to their soft bodies that quickly decompose. The lack of shiners in the diet could also be due to different habitat usage, low abundance compared to other prey items, or preference for other prey items.

Saugers were apparently utilizing food items that were readily available to them in Lewis and Clark Lake. Channel catfish *Ictalurus punctatus*, gizzard shad, and freshwater drum were common components of the fish community in Lewis and Clark Lake during 2003 (Wickstrom 2004) when stomach samples were obtained for food habits evaluation. Mayfly larvae comprise a substantial portion of the benthic invertebrate biomass in Lewis and Clark Lake (Cowell and Hudson 1968). The findings of this study confirm previous reports that sauger feed on a variety of small fishes and invertebrates (Scott and Crossman 1973; Eddy and Underhill 1974).

WALLEYE FOOD HABITS

A total of 370 walleye stomachs were examined and 133 (35.9%) were found to be empty. Food habit analysis was completed for 237 walleyes.

Walleyes ate a greater variety of organisms than saugers. Fishes were consumed by all size classes of walleye during all seasons sampled and comprised nearly 100% of the diet by weight during autumn (Table 13). Fishes comprised a large portion of the diet, by weight, for the smallest (150-249 mm) walleyes during summer, mid-size (380-509 mm) walleyes during spring, and large (>509 mm) walleyes, spring through autumn. Freshwater drum was the dominant food item, by weight, for all sizes of walleye during spring. Gizzard shad was the dominant food item, by weight, for all sizes of walleye during autumn. Gizzard shad was an important walleye food item in Lake Francis Case, a Missouri River reservoir, during autumn (Unkenholz et al. 1982). Catfish, most likely channel catfish, was eaten by all walleye size groups in Lewis and Clark Lake, but only during the spring. Fathead minnows *Pimephales promelas* and black bullheads *Ameiurus melas* were prominent food items for walleyes in Lake Thompson, South Dakota (Isaak et al. 1993). Darters *Etheostoma spp.* were the primary food during all months and for all length groups of walleyes in Lake Cochrane, South Dakota (Starostka et al. 1996). River carpsuckers *Carpoides carpio* were eaten only by mid-size walleyes in Lewis and Clark Lake, and only in the limnetic locations of the upper zone during spring. Shiners *Notropis spp*. were the dominant food item during summer for the smallest and the largest walleyes. Age-0 walleyes and saugers served as food items for all sizes of walleyes only during autumn. Scott and Crossman (1973) stated that yellow perch *Perca flavescens* and freshwater drum were important walleye food items and Blackwell et al. (1999) reported that yellow perch was the primary food item for walleyes in Enemy Swim Lake, South Dakota. Slipke (1996) found that walleyes were selecting yellow perch and white bass *Morone chrysops* over more abundant shiners at Shadehill Reservoir, South Dakota. No yellow perch were found in any walleye stomach in this study. Yellow perch were in low abundance in 2003 (Wickstrom 2004) when walleye stomach samples were obtained for food habits evaluation.

Invertebrates form a large part of the walleye diet during spring and early summer (Colby et al. 1979). Benthic invertebrates were consumed by all sizes of walleyes during spring and summer at Lewis and Clark Lake. Mayfly larvae was the dominant food item, by weight, during spring and summer for small (250-379 mm) walleyes and during the summer for mid-size walleyes. Mayfly larvae was an important food item in the spring at Lakes Francis Case (Unkenholz et al. 1982), Enemy Swim (Blackwell et al. 1999), Kampeska, South Dakota (Blackwell et al 1999), and were consumed spring through autumn at Lake Thompson, South Dakota (Isaak et al. 1993).

This highest incidence of unidentified fishes reported occurred during autumn when fishes comprised nearly 100% of the diet and the water temperature was over 20 ^{0}C (Appendix 14). Similar to saugers, the high proportion of unidentified fishes is likely the result of earlier feeding and decomposition of food items while the walleyes were being held in gill nets. The lowest incidence of unidentified fishes in the diet occurred during spring when the lowest water temperature was recorded.

Adult and juvenile walleyes are largely piscivorous (Colby et al. 1979) and will utilize any species of fish available to them (Scott and Crossman 1973). Gizzard shad, freshwater drum, river carpsuckers, shiners, and age-0 walleyes and saugers were common in Lewis and Clark Lake (Wickstrom 2004) when stomach samples were obtained for food habits evaluation during 2003. Mayfly larvae dominate the benthic invertebrate biomass in Lewis and Clark Lake (Cowell and Hudson 1968). Invertebrates are gradually replaced by fishes in the walleye diet after aquatic insects emerge and age-0 fishes become readily available (Colby et al. 1979). This diet progression was followed by walleyes in Lewis and Clark Lake during summer and autumn 2003.

SAUGER AND WALLEYE FOOD OVERLAP

A Schoener index value of 60 may indicate diet overlap of biological significance (Wallace 1981). Sauger and walleye diet overlap values exceeded 60 during summer and autumn both with unidentified fishes and without unidentified fishes (Table 14). *Hexagenia sp*. larvae and shiners were important to both species during summer. Gizzard shad and freshwater drum comprised nearly 100% of the diet of both species during autumn.

Table 12. Diet summary by season, reservoir strata, and length group for saugers caught in gill nets from Lewis and Clark Lake during 2003. N is the number of stomachs examined.

Season	Strata	Length (mm)	N	% Empty	Taxon	% Occurrence	% Number	% Weight
Spring	Upper-littoral	200-299	5	80.0	*Hexagenia sp.*	20.0	100.0	100.0
		300-379	9	44.4	Ictaluridae	22.2	14.3	83.3
					Hexagenia sp.	44.4	85.7	16.2
		>379	14	63.3	Ictaluridae	35.7	100.0	100.0
Spring	Upper-limnetic	200-299	2	50.0	*Hexagenia sp.*	50.0	75.0	99.9
					Tricoptera	50.0	25.0	0.01
		300-379	6	66.7	*Pimephales sp.*	16.7	100.0	99.7
					Detritus	16.7	-	0.03
		>379	12	33.3	Ictaluridae	58.3	57.1	89.0
					Hexagenia sp.	16.7	35.7	0.6
					Amphibia	8.3	7.1	10.4
Spring	Lower-littoral	200-299	7	28.6	Unidentified fishes	14.3	11.1	16.3
					Hexagenia sp.	57.1	77.8	83.1
					Tricoptera	14.3	11.1	0.6
		300-379	10	70.0	Unidentified fishes	10.0	6.7	10.4
					Ictaluridae	10.0	6.7	11.8
					Hexagenia sp.	60.0	80.0	74.7
					Isopoda	10.0	6.7	3.1
		>379	9	11.1	Unidentified fishes	11.1	11.1	10.4
					Sander spp.	11.1	11.1	22.9
					Ictaluridae	22.2	22.2	16.1
					Aplodinotus grunniens	22.2	22.2	39.1

Table 12 continued…

					Notropis spp.	11.1	11.1	11.5
					Hexagenia sp.	22.2	22.2	0.1
Spring	Lower-limnetic	200-299	5	20.0	Hexagenia sp.	80.0	100.0	100.0
		300-379	17	35.5	Ictaluridae	29.4	12.5	88.2
					Hexagenia sp.	35.5	85.5	11.7
					Tricoptera	5.9	2.5	0.1
		>379	13	23.1	Ictaluridae	53.8	50.0	48.5
					Aplodinotus grunniens	7.7	7.1	50.5
					Hexagenia sp.	23.1	35.7	1.0
					Amphipoda	7.7	7.1	0.01
Spring	Combined	200-299	19	42.1	Unidentified fishes	5.3	4.8	6.1
					Hexagenia sp.	52.6	85.7	93.7
					Tricoptera	10.5	9.5	0.2
		300-379	42	45.2	Unidentified fishes	2.4	1.4	0.5
					Ictaluridae	19.0	11.4	76.5
					Pimephales sp.	2.4	1.4	6.0
					Hexagenia sp.	38.1	82.9	16.5
					Tricoptera	2.4	1.4	0.02
					Isopoda	2.4	1.4	0.2
					Detritus	2.4	-	0.01
		>379	48	35.4	Unidentified fishes	2.1	2.4	4.0
					Sander spp.	2.1	2.4	8.9
					Ictaluridae	43.8	52.4	52.3
					Aplodinotus grunniens	6.3	7.1	26.9

Table 12 continued…

					Notropis spp.	2.1	2.4	4.5
					Hexagenia sp.	14.6	28.6	0.4
					Amphipoda	2.1	2.4	0.002
					Amphibia	2.1	2.4	2.9
Spring	Combined	All	109	38.5	Unidentified fishes	2.8	2.3	3.6
					Sander spp.	0.9	0.8	7.7
					Ictaluridae	26.6	22.6	54.9
					Aplodinotus grunniens	2.8	2.3	23.4
					Notropis spp.	0.9	0.8	3.9
					Pimephales sp.	0.9	0.8	0.7
					Hexagenia sp.	30.3	66.1	3.2
					Tricoptera	2.8	2.3	0.0004
					Isopoda	0.9	0.8	0.03
					Amphipoda	0.9	0.8	0.002
					Amphibia	0.9	0.8	2.5
					Detritus	0.9	-	0.002
Summer	Upper-littoral	160-199	3	33.3	Unidentified fishes	99.7	100.0	100.0
		200-299	1	100.0	*Notropis spp.*	100.0	100.0	100.0
		300-379	3	33.3	*Aplodinotus grunniens*	33.3	50.0	27.3
					Notropis spp.	33.3	50.0	72.7
		>379	11	54.5	*Hexagenia sp.*	36.4	95.0	90.1
					Odonata	9.1	5.0	9.9

Table 12 continued…

Summer	Upper-limnetic	200-299	1	0.0	*Hexagenia sp.*	100.0	100.0	100.0
		300-379	2	50.0	*Hexagenia sp.*	50.0	100.0	100.0
				66.7	Unidentified fishes	11.1	40.0	74.6
					Hexagenia sp.	22.2	40.0	5.8
					Odonata	11.1	20.2	189.6
Summer	Lower-littoral	200-299	2	50.0	*Notropis spp.*	50.0	100.0	100.0
		300-379	11	54.5	Unidentified fishes	9.1	13.8	17.6
					Hexagenia sp.	27.3	84.5	81.3
					Odonata	9.1	1.74	1.2
		>379	9	77.8	Unidentified invertebrates	11.1	3.8	6.2
					Hexagenia sp.	2.2	40.0	41.8
					Tricoptera	11.1	30.3	15.3
					Odonata	11.1	10.0	30.8
Summer	Lower-limnetic	200-299	9	77.8	Unidentified invertebrates	11.1	3.8	6.2
					Hexagenia sp.	11.1	96.2	93.8
		300-379	35	71.4	Unidentified fishes	5.7	16.7	24.0
					Notropis spp.	2.9	8.3	8.6
					Unidentified invertebrates	2.9	8.3	1.9
					Hexagenia sp.	17.1	58.3	65.1
					Chironomidae	2.9	8.2	0.4
		>379	22	81.8	Unidentified fishes	9.1	50.0	43.6
					Unidentified invertebrates	4.5	12.5	0.01
					Hexagenia sp.	9.1	37.5	56.4

Table 12 continued…

Summer	Combined	200-299	13	61.5	*Notropis spp.*	15.4	6.1	3.8
					Unidentified invertebrates	7.7	3.0	5.6
					Hexagenia sp.	15.4	90.9	90.9
		300-379	51	62.7	Unidentified fishes	5.9	12.7	17.0
					Aplodinotus grunniens	2.0	1.3	1.6
					Notropis spp.	3.9	2.5	6.6
					Unidentified invertebrates	2.0	1.3	0.6
					Hexagenia sp.	19.6	79.7	73.6
					Odonata	2.0	1.3	0.7
					Chironomidae	2.0	1.3	0.1
		>379	51	70.4	Unidentified fishes	7.8	18.6	32.5
					Unidentified invertebrates	2.0	2.3	0.01
					Hexagenia sp.	19.6	65.1	53.1
					Tricoptera	2.0	7.0	2.4
					Odonata	5.9	7.0	12.1
Summer	Combined	All	115	67.0	Unidentified fishes	6.1	11.6	17.1
					Aplodinotus grunniens	0.9	0.6	0.7
					Notropis spp.	3.5	2.6	4.0
					Unidentified invertebrates	2.6	1.9	1.6
					Hexagenia sp.	19.1	78.1	72.1
					Tricoptera	0.9	1.9	0.7
					Odonata	3.5	2.6	3.7
					Chironomidae	0.9	0.6	0.1

Table 12 continued…

Autumn	Upper-littoral	200-299	7	14.3	Unidentified fishes	71.4	71.4	85.0
					Aplodinotus grunniens	14.3	14.3	15.0
					Chironomidae	14.3	14.3	0.01
		300-379	11	27.3	Unidentified fishes	72.7	100.0	100.0
		>379	15	33.3	Unidentified fishes	6.7	86.7	62.0
					Dorosoma cepedianum	13.3	13.3	37.9
					Detritus	6.7	-	0.1
Autumn	Upper-limnetic	200-299	1	0.0	Unidentified fishes	100.0	100.0	100.0
		300-379	6	50.0	Unidentified fishes	50.0	75.0	39.9
					Dorosoma cepedianum	16.7	25.0	60.1
		>379	17	29.4	Unidentified fishes	58.8	85.7	56.8
					Ictaluridae	5.9	4.8	19.9
					Dorosoma cepedianum	11.8	5.9	23.3
Autumn	Lower-littoral	200-299	8	50.0	*Aplodinotus grunniens*	50.0	83.3	52.1
					Dorosoma cepedianum	12.5	16.7	47.9
		300-379	9	33.3	Unidentified fishes	33.3	50.0	49.6
					Aplodinotus grunniens	22.2	25.0	19.6
					Dorosoma cepedianum	11.1	12.5	29.6
					Hexagenia sp.	11.1	12.5	1.2
		>379	5	60.0	*Sander spp.*	20.0	50.0	70.5
					Dorosoma cepedianum	20.0	50.0	29.5
		300-379	20	55.0	Unidentified fishes	25.0	60.0	57.8

Table 12 continued.

Autumn	Lower-limnetic	200-299	5	60.0	Unidentified fishes	40.0	100.0	100.0
					Aplodinotus grunniens	20.0	40.0	42.2
		>379	17	41.2	Unidentified fishes	40.0	53.8	39.4
					Aplodinotus grunniens	17.6	38.4	43.4
					Dorosoma cepedianum	5.9	7.7	17.2
Autumn	Combined	200-299	21	33.3	Unidentified fishes	38.1	50.0	57.1
					Aplodinotus grunniens	23.8	37.5	26.1
					Dorosoma cepedainum	4.8	6.3	16.8
					Chironomidae	4.8	6.3	0.002
		300-379	46	41.3	Unidentified fishes	41.3	71.9	60.2
					Aplodinotus grunniens	13.0	18.8	13.8
					Dorosoma cepedianum	4.3	6.3	25.8
					Hexagenia sp.	2.2	3.1	0.2
		>379	54	37.0	Unidentified fishes	50.0	74.5	46.1
					Sander spp.	1.9	2.0	11.7
					Ictaluridae	1.9	2.0	8.5
					Aplodonotus grunniens	5.6	9.8	6.4
					Dorosoma cepedianum	11.1	11.8	27.2
					Detritus	1.9	-	0.02
Autumn	Combined	All	121	38.0	Unidentified fishes	44.6	69.7	51.1
					Sander spp.	0.8	1.0	7.3
					Ictaluridae	0.8	1.0	5.3

Table 12 continued…

					Aplodinotus grunniens	11.6	17.2	10.4
					Dorosoma cepedianum	7.5	9.1	25.8
					Hexagenia sp.	0.8	1.0	0.05
					Chironomidae	0.8	1.0	0.0002
					Detritus	0.8	-	0.01

Table 13. Diet summary by season, reservoir strata, and length group for walleyes caught in gill nets from Lewis and Clark Lake during 2003. N is the number of stomachs examined.

Season	Strata	Length (mm)	Number	% Empty	Taxon	% Occurrence	% Number	% Weight
Spring	Upper-littoral	250-379	10	0.0	*Notropis spp.*	10.0	1.0	28.8
					Unidentified invertebrate	10.0	1.0	0.2
					Hexagenia sp.	90.0	81.6	62.7
					Other Ephemeroptera	10.0	1.0	0.6
					Chironomidae	10.0	1.0	0.1
					Culicidae	10.0	11.2	1.3
					Odonata	10.0	1.0	4.2
					Tricoptera	10.0	1.0	0.1
					Isopoda	10.0	1.0	2.0
					Detritus	10.0	-	0.1
		380-509	11	9.1	Unidentified fishes	4.5	1.5	66.3
					Aplodinotus grunniens	18.2	0.4	15.7
					Hexagenia sp.	54.5	96.3	17.7
					Other Ephemeroptera	9.1	0.2	0.02
					Chironomidae	9.1	0.7	0.03
					Tricoptera	27.3	0.9	0.1
					Detritus	9.1	-	0.1

Table 13 continued.

		>509	2	0.0	*Aplodinotus grunniens*	50.0	0.1	14.1
					Hexagenia sp.	100.0	99.9	85.9
Spring	Upper-limnetic	250-379	7	14.3	Catfish	14.3	0.2	13.1
					Unidentified invertebrates	42.9	6.7	0.02
					Hexagenia sp.	42.9	12.7	64.6
					Other Ephemeroptera	14.3	0.2	0.02
					Culicidae	14.3	0.2	0.02
					Tricoptera	57.1	1.4	1.9
					Cladocera	42.9	78.5	19.8
					Detritus	42.9	-	0.6
		380-509	14	28.6	Ictaluridae	7.1	0.1	4.3
					Carpiodes carpio	7.1	0.1	80.8
					Unidentified invertebrates	7.1	0.2	0.01
					Hexagenia sp.	50.0	95.9	14.4
					Other Ephemeroptera	7.1	0.2	0.02
					Chironomidae	7.1	0.1	0.005
					Culicidae	14.3	0.3	0.001
					Odonata	28.6	0.4	0.2
					Tricoptera	35.7	2.2	0.1
					Plecoptera	21.4	0.4	0.03
					Detritus	35.7	-	0.1
		>509	7	28.6	Unidentifies fishes	14.3	1.0	0.1
					Ictaluridae	28.6	2.1	14.0
					Aplodinotus grunniens	28.6	3.1	73.5
					Notropis spp.	14.3	1.0	8.0

Table 13 continued.

					Unidentified invertebrates	14.3	2.1	0.03
					Hexagenia sp.	28.6	86.5	4.2
					Tricoptera	14.3	1.0	0.01
					Plecoptera	14.3	3.1	0.1
					Detritus	14.3	-	0.03
Spring	Lower-littoral	250-379	12	16.7	*Aplodinotus grunniens*	8.3	0.5	29.3
					Unidentified invertebrates	8.3	6.0	0.1
					Hexagenia sp.	75.0	90.7	69.6
					Other Ephemeroptera	8.3	0.5	0.004
					Chironomidae	25.0	1.6	0.9
					Plecoptera	8.3	0.5	0.1
		380-509	15	26.7	Unidentified fishes	6.7	0.7	6.3
					Aplodinotus grunniens	6.7	0.7	11.7
					Unidentified invertebrates	6.7	0.7	0.01
					Hexagenia sp.	53.3	91.2	81.3
					Chironomidae	6.7	0.7	0.1
					Culicidae	13.3	3.6	0.2
					Tricoptera	6.7	1.5	0.1
					Plecoptera	6.7	0.7	0.3
		>509	4	0.0	Unidentified fishes	25.0	1.6	0.5
					Aplodinotus grunniens	50.0	3.2	92.4
					Hexagenia sp.	50.0	93.5	7.1
					Tricoptera	25.0	1.6	0.01
					Detritus	25.0	-	0.01

Table 13 continued.

Spring	Lower-limnetic	250-379	14	28.6	*Notropis spp.*	7.1	0.6	28.1
					Hexagenia sp.	64.3	83.9	71.5
					Culicidae	14.3	1.2	0.04
					Tricoptera	7.1	0.6	0.05
					Cladocera	14.3	13.7	0.3
					Detritus	14.3	-	0.04
		380-509	7	28.6	Unidentified fishes	14.3	0.3	3.4
					Aplodinotus grunniens	14.3	0.7	75.6
					Hexagenia sp.	28.6	97.3	20.8
					Tricoptera	14.3	0.3	0.02
					Diptera	14.3	1.0	0.002
					Coleoptera	14.3	0.3	0.001
					Detritus	14.3	-	0.2
		>509	3	33.3	*Notropis spp.*	66.7	100.0	100.0
Spring	Combined	250-379	43	18.6	Ictaluridae	2.3	0.1	1.0
					Aplodinotus grunniens	2.3	0.1	12.0
					Notropis spp.	4.7	0.2	14.6
					Unidentified invertebrates	7	1.5	0.1
					Hexagenia sp.	69.8	51.8	68.5
					Other Ephemeroptera	7.0	0.4	0.1
					Chironomidae	9.3	0.5	0.4
					Culicidae	9.3	1.6	0.3
					Odonata	2.3	0.1	0.8
					Tricoptera	14.0	0.9	0.2
					Plecoptera	2.3	0.1	0.02

Table 13 continued.

			Isopoda	2.3	0.1	0.4
			Cladocera	11.6	42.5	1.6
			Detritus	14	-	0.1
380-509	47	27.7	Unidentified fishes	14.9	0.5	11.5
			Ictaluridae	2.1	0.1	2.1
			Aplodinotus gruniens	8.5	0.3	25.7
			Carpiodes carpio	2.1	0.1	40.6
			Unidentified invertebrates	4.3	0.2	0.004
			Hexagenia sp.	48.9	95.8	19.6
			Other Ephemeroptera	4.3	0.2	0.01
			Chironomidae	6.4	0.3	0.005
			Culicidae	8.5	0.4	0.01
			Odonata	8.5	0.2	0.1
			Tricoptera	21.2	1.5	0.1
			Plecoptera	8.5	0.3	0.03
			Other Diptera	2.1	0.2	0.001
			Coleoptera	2.1	0.1	0.0002
			Detritus	14.9	-	0.1
>509	16	18.8	Unidentified fishes	12.5	0.2	0.2
			Ictaluridae	12.5	0.2	4.6
			Aplodinotus grunniens	31.3	0.7	63.7
			Notropis spp.	18.8	0.4	11.1
			Unidentified invertebrates	6.3	0.2	0.0
			Hexagenia sp.	37.5	97.6	20.4
			Tricoptera	12.5	0.2	0.01
			Plecoptera	6.3	0.4	0.04

Table 13 continued.

					Detritus	12.5	-	0.0
Spring	Combined	All	106	22.6	Unidentified fishes	8.5	0.3	5.5
					Ictaluridae	3.8	0.1	3.2
					Aplodinotus grunniens	9.4	0.3	42.4
					Notropis spp.	4.7	0.1	6.1
					Carpiodes carpio	0.9	0.03	19.2
					Unidentified invertebrates	5.7	0.5	0.01
					Hexagenia sp.	55.7	85.5	23.2
					Other Ephemeroptera	4.7	0.2	0.01
					Chironomidae	6.6	0.3	0.03
					Culicidae	7.5	0.6	0.02
					Odonata	4.7	0.1	0.1
					Tricoptera	17.0	1.1	0.1
					Plecoptera	5.7	0.3	0.03
					Isopoda	0.9	0.03	0.02
					Cladocera	4.7	10.3	0.1
					Other Diptera	0.9	0.9	0.0003
					Coleoptera	0.9	0.03	0.0001
					Dettitus	14.2	-	0.1
Summer	Upper-littoral	150-249	11	36.4	Unidentified fishes	36.4	31.3	22.9
					Notropis spp.	27.3	25.0	64.5
					Hexaginia sp.	18.2	18.8	3.4
					Chironomidae	9.1	18.8	2.0
					Odonata	9.1	6.3	7.3

Table 13 continued.

		250-379	11	81.8	Unidentified fishes	9.1	52.6	28.8
					Notropis spp.	9.1	5.3	28.5
					Hexagenia sp.	18.2	36.8	42.2
					Plecoptera	9.1	5.3	0.5
		380-509	4	50.0	*Notropis pp.*	50.0	27.3	71.5
					Hexagenia sp.	50.0	69.7	28.1
					Odonata	25.0	3.0	0.3
		>509	2	0.0	*Hexagenia sp.*	100.0	95.2	97.2
					Odonata	50.0	4.8	2.8
Summer	Upper-limnetic	150-249	4	0.0	Unidentified fishes	75.0	75.0	31.7
					Notropis spp.	25.0	12.5	64.1
					Hexagenia sp.	25.0	12.5	4.2
		250-379	14	64.3	Unidentified fishes	7.1	2.1	22.6
					Hexagenia sp.	35.7	95.7	75.6
					Chironomidae	7.1	2.1	1.8
		380-509	10	40.0	Unidentified fishes	1.0	2.6	21.6
					Hexagenia sp.	40.0	87.0	55.6
					Odonata	40.0	10.4	22.8
		>509	10	90.0	*Notropis spp.*	10.0	50.0	99.4
					Other Ephemeroptera	10.0	50.0	0.6
Summer	Lower-littoral	150-249	7	42.9	Unidentified fishes	14.3	8.3	6.9
					Notropis spp.	14.3	8.3	53.1
					Hexagenia sp.	28.6	66.7	23.1
					Odonata	14.3	16.7	16.9

Table 13 continued.

		250-379	16	43.8	*Hexagenia sp.*	50.0	100.0	96.1
					Detritus	6.3	-	3.9
		380-509	4	25.0	*Hexagenia sp.*	50.0	80.0	92.4
					Odonata	25.0	20.0	7.6
Summer	Lower-limnetic	150-249	4	0.0	Unidentified fishes	25.0	2.6	0.5
					Unidentified invertebrates	25.0	2.6	2.6
					Hexagenia sp.	50.0	78.9	68.1
					Other Ephemeroptera	25.0	15.8	28.8
		250-379	20	60.0	Unidentified fishes	15.0	10.0	5.4
					Unidentified Invertebrates	50.0	2.0	9.8
					Hexagenia sp.	30.0	88.0	84.8
		380-509	3	66.7	*Hexagenia sp.*	33.3	100.0	100.0
		>509	3	100.0				
Summer	Combined	150-249	26	26.9	Unidentified fishes	34.6	17.6	16.0
					Notropis spp.	19.2	8.1	45.4
					Unidentified invertebrates	3.8	1.4	0.7
					Hexagenia sp.	26.9	56.8	24.3
					Other Ephemeroptera	3.8	8.1	7.5
					Chironomidae	3.8	4.1	0.6
					Odonata	7.7	4.1	5.5
		250-379	61	57.4	Unidentified fishes	8.2	6.5	7.0
					Notropis spp.	1.6	0.4	2.1
					Unidentified invertebrates	1.6	0.4	2.0

Table 13 continued.

					Hexagenia sp.	34.4	91.9	86.4
					Chironomidae	1.6	0.4	0.4
					Plecoptera	1.6	0.43	0.04
					Detritus	1.6	-	2.1
		380-509	21	42.9	Unidentified fishes	4.8	1.2	14.2
					Notropis spp.	9.5	5.5	10.4
					Hexagenia sp.	42.9	87.3	60.1
					Odonata	28.6	6.1	15.3
		>509	15	80.0	*Notropis spp.*	6.7	4.3	76.3
					Hexagenia sp.	13.3	87.0	22.6
					Other Ephemeroptera	6.7	4.3	0.5
					Odonata	6.7	4.3	0.7
Summer	Combined	All	123	52.0	Unidentified fishes	12.2	6.1	9.6
					Notropis spp.	7.3	3.3	22.3
					Unidentified invertebrates	1.6	0.4	0.9
					Hexagenia sp.	31.7	85.1	59.3
					Other Ephemeroptera	1.6	1.4	1.4
					Chironomidae	1.6	0.8	0.2
					Odonata	7.3	2.8	5.3
					Plecoptera	0.8	0.2	0.02
					Detritus	0.8	-	0.9
					Sander spp.	7.7	5.9	26.2
Autumn	Upper-littoral	250-379	13	23.1	Unidentified fishes	53.8	58.8	31.9
					Aplodinotus gruniens	7.7	5.9	10.5

Table 13 continued.

					Notropis spp.	7.7	11.8	29.4
					Hexagenia sp.	7.7	5.9	0.4
					Chironomidae	7.7	11.8	0.1
					Detritus	15.4	-	1.4
		380-509	14	28.6	Unidentified fishes	71.4	88.2	48.8
					Sander spp.	7.1	5.9	48.3
					Aplodinotus grunniens	7.1	5.9	2.9
		>509	5	60.0	Unidentified Fishes	40.0	66.7	75.9
					Dorosoma cepedianum	20.0	33.3	24.1
Autumn	Upper-limnetic	250-379	14	28.6	Unidentified fishes	57.1	71.4	60.0
					Notropis spp.	7.1	14.3	4.0
					Gizzard shad	7.1	7.1	36.0
					Hexagenia sp.	7.1	7.1	0.4
		380-509	11	0.0	Unidentified fishes	63.6	50.0	11.5
					Dorosoma cepedianum	54.5	50.0	88.5
		>509	10	20.0	Unidentified fishes	60.0	59.1	32.0
					Aplodinotus grunniens	20.0	27.3	31.5
					Dorosoma cepedianum	10.0	13.6	36.4
Autumn	Lower-littoral	150-249	1	0.0	Unidentified fishes	100.0	50.0	5.9
					Dorosoma cepedianum	100.0	50.0	94.1
		250-379	15	33.3	Unidentified fishes	33.3	47.4	23.5
					Sander spp.	66.7	5.3	15.6
					Aplodinotus gruniens	20.0	21.1	17.4
					Notropis spp.	6.7	5.3	8.8

Table 13 continued.

					Dorosoma cepedianum	13.3	15.8	28.7
					Centrarchidae	6.7	5.3	6.0
		380-509	12	16.7	Unidentified fishes	50.0	61.1	20.6
					Sander spp.	8.3	5.6	38.3
					Aplodinotus grunniens	8.3	5.6	2.8
					Dorosoma cepedianum	8.3	5.6	19.2
					Centrarchidae	8.3	5.6	18.9
					Hexagenia sp.	16.7	16.7	0.2
		>509	5	0.0	*Sander spp.*	20.0	9.1	26.8
					Aplodinotus grunniens	60.0	54.5	72.3
					Hexagenia sp.	20.0	36.4	0.8
Autumn	Lower-limnetic	250-379	19	47.4	Unidentifies fishes	47.4	83.3	58.1
					Aplodinotus gruniens	5.3	16.7	41.9
		380-509	17	41.2	Unidentifies fishes	35.3	53.3	40.9
					Aplodinotus grunniens	29.4	46.7	59.1
		>509	5	40.0	*Aplodinotus gruniens*	20.0	50.0	50.6
					Notropis spp.	20.0	16.7	7.6
					Dorosoma cepedianum	20.0	16.7	40.8
					Hexagenia sp.	20.0	16.7	0.9
Autumn	Combined	250-379	61	34.4	Unidentified fishes	47.5	62.9	37.6
					Sander spp.	3.3	3.2	11.3
					Aplodinous grunniens	8.2	11.3	19.9
					Notropis spp.	4.9	8.1	10
					Dorosoma cepedianum	4.9	6.5	18.5

Table 13 continued.

					Centrarchidae	1.6	1.6	2.3
					Hexagenia sp.	3.3	3.2	0.1
					Chironomidae	1.6	3.2	0.01
					Detritus	3.3	-	0.3
		380-509	54	24.1	Unidentified fishes	53.7	62.5	24.6
					Sander spp.	3.7	2.8	20.2
					Aplodinotus grunniens	13.0	12.5	7.9
					Dorosoma cepedianum	13.0	16.7	41.9
					Centrarchidae	1.9	1.4	5.4
					Hexagenia sp.	3.7	4.2	0.1
		>509	25	24.1	Unidentified fishes	32.0	35.7	34.0
					Sander spp.	4.0	2.4	7.2
					Aplodinotus grunniens	24.0	35.7	34.7
					Notropis spp.	4.0	2.4	0.3
					Dorosoma grunniens	12.0	11.9	23.4
					Hexagenia sp.	8.0	11.9	0.3
Autumn	Combined	All	141	31.9	Unidentified fishes	47.5	56.2	31.3
					Sander spp.	3.5	2.8	12.8
					Aplodinotus grunniens	12.8	17.4	20.9
					Notropis spp.	2.8	3.8	2.1
					Dorosoma cepedianum	9.9	12.4	30.2
					Centrarchidae	1.4	1.1	2.5
					Hexagenia sp.	4.3	5.6	0.2
					Chironomidae	0.7	1.1	0.003
					Detritus	1.4	-	0.1

Table 14. Percent diet overlap (Shoener index; Schoener 1971) by season between sauger and walleye at Lewis and Clark Lake during 2003.

Season	% overlap with unidentified fish	% overlap without unidentified fish
Spring	27.6	38.5
Summer	78.1	81.8
Autumn	75.9	71.6

SUMMARY

Walleyes in the Missouri River between Ft. Randall and Gavins Point Dams exhibited more movement than saugers. At time of tagging, walleyes were predominately found in the upper river and most were recaptured there. Although 48% of the walleyes showed no movement from the original capture site, 6% traveled more than 80 km. Walleye movement was mostly down river and nearly 4% passed through Gavins Point Dam unharmed. Saugers were initially captured predominately in the reservoir and most were recaptured there. Nearly 38% of the saugers showed no movement from the original capture site and none moved 80 km or more. Sauger movement was also primarily down river, similar to walleye, and 3% passed unharmed through Gavins Point Dam.

Sauger abundance was higher in the lower reservoir zone at limnetic locations than littoral locations during spring and summer. Differences in walleye abundance were not as well defined, but in spring and summer greater numbers of walleye were generally found in limnetic areas of the upper zone. During autumn abundance was similar throughout the reservoir.

A primary difference between walleye and sauger behavior is that during autumn the larger individuals are found in different habitats in the upper reservoir. Larger average length saugers were found in limnetic areas of the upper zone and larger average length walleyes were in the littoral areas of the upper zone. A proportionately greater number of larger saugers were found at littoral locations during spring and limnetic locations during autumn. A greater number larger walleyes were found at limnetic locations and in the upper zone during summer.

Saugers and walleyes in Lewis and Clark Lake followed the same fish to invertebrates to fish diet progression during spring through autumn. What differed between the two species was the fish species dominant in the diet during spring. Saugers ate mostly catfish and freshwater drum, while walleyes ate mostly river carpsuckers and freshwater drum. Mayfly larvae predominated in the diet of both saugers and walleyes, followed by shiners, during summer. Gizzard shad and freshwater drum were predominate diet items for both saugers and walleyes during autumn.

It appears that sufficient quantity and quality of prey items for saugers and walleyes could be a problem at Lewis and Clark Lake when food items are in short supply. Seasonal distribution of sauger and walleye was similar and it appears they are competing for the same food items during summer and autumn. Diet overlap could be the reason that moderate *Wr* values are observed for both species during autumn of most years.

Gill net caught fish are generally not suitable for food habits studies because of the loss of information from regurgitation of food items (Bowen 1996). Digestion of food items while captured fishes are held for a period of time in gill nets also causes a loss of information. A high incidence of empty stomachs and unidentified fishes were obtained in this study. However, fish caught in gill nets for the sauger and walleye distribution in Lewis and Clark Lake portion of this study were put to good use by also examining their food habits.

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APPENDICES

Appendix 1. Universal transverse mercator coordinates for gill net locations in Lewis and Clark Lake during 2002.

Year	Season	Zone	Location	X	Y
2002	Spring	Upper	Near shore	601293	4745787
2002	Spring	Upper	Near shore	605672	4745796
2002	Spring	Upper	Near shore	604196	4742377
2002	Spring	Upper	Off shore	606607	4744185
2002	Spring	Upper	Off shore	605983	4742730
2002	Spring	Upper	Off shore	602304	4743644
2002	Spring	Lower	Near shore	616962	4743778
2002	Spring	Lower	Near shore	622797	4747141
2002	Spring	Lower	Near shore	618472	4743824
2002	Spring	Lower	Off shore	616436	4744556
2002	Spring	Lower	Off shore	612295	4744533
2002	Spring	Lower	Off shore	617832	4745219
2002	Summer	Upper	Near shore	600637	4743243
2002	Summer	Upper	Near shore	601049	4746462
2002	Summer	Upper	Near shore	607815	4745571
2002	Summer	Upper	Off shore	605483	4745173
2002	Summer	Upper	Off shore	602969	4743721
2002	Summer	Upper	Off shore	601068	4745475
2002	Summer	Lower	Near shore	614772	4746711
2002	Summer	Lower	Near shore	613574	4744093
2002	Summer	Lower	Near shore	620132	4743723
2002	Summer	Lower	Off shore	620712	4744708
2002	Summer	Lower	Off shore	613520	4745413
2002	Summer	Lower	Off shore	620701	4745800
2002	Autumn	Upper	Near shore	604199	4742472
2002	Autumn	Upper	Near shore	609363	4745687
2002	Autumn	Upper	Near shore	601141	4742713
2002	Autumn	Upper	Off shore	605920	4745530
2002	Autumn	Upper	Off shore	610586	4744335
2002	Autumn	Upper	Off shore	610273	4744577
2002	Autumn	Lower	Near shore	617528	4745402
2002	Autumn	Lower	Near shore	612180	4746611
2002	Autumn	Lower	Near shore	620658	4746241
2002	Autumn	Lower	Off shore	616234	4743539
2002	Autumn	Lower	Off shore	616390	4745118
2002	Autumn	Lower	Off shore	620345	4745815

Appendix 2. Universal transverse mercator coordinates for gill net locations in Lewis and Clark Lake during 2003.

Year	Season	Zone	Location	X	Y
2003	Spring	Upper	Near shore	611295	4746032
2003	Spring	Upper	Near shore	609131	4745846
2003	Spring	Upper	Near shore	608918	4742864
2003	Spring	Upper	Off shore	606288	4744363
2003	Spring	Upper	Off shore	601528	4744734
2003	Spring	Upper	Off shore	607833	4744301
2003	Spring	Lower	Near shore	615175	4746737
2003	Spring	Lower	Near shore	620588	4743764
2003	Spring	Lower	Near shore	621500	4746506
2003	Spring	Lower	Off shore	620216	4745485
2003	Spring	Lower	Off shore	620644	4744793
2003	Spring	Lower	Off shore	619260	4744332
2003	Summer	Upper	Near shore	603313	4746404
2003	Summer	Upper	Near shore	610301	4743699
2003	Summer	Upper	Near shore	609512	4743248
2003	Summer	Upper	Off shore	607145	4744713
2003	Summer	Upper	Off shore	605567	4744150
2003	Summer	Upper	Off shore	603877	4742760
2003	Summer	Lower	Near shore	617778	4743887
2003	Summer	Lower	Near shore	614847	4743887
2003	Summer	Lower	Near shore	619807	4746028
2003	Summer	Lower	Off shore	617214	4744000
2003	Summer	Lower	Off shore	612255	4744263
2003	Summer	Lower	Off shore	614622	4744150
2003	Autumn	Upper	Near shore	606524	4742496
2003	Autumn	Upper	Near shore	609036	4745396
2003	Autumn	Upper	Near shore	602756	4745576
2003	Autumn	Upper	Off shore	602634	4744065
2003	Autumn	Upper	Off shore	610848	4744970
2003	Autumn	Upper	Off shore	607959	4743692
2003	Autumn	Lower	Near shore	617737	4745396
2003	Autumn	Lower	Near shore	619800	4743960
2003	Autumn	Lower	Near shore	612803	4744230
2003	Autumn	Lower	Off shore	620338	4745486
2003	Autumn	Lower	Off shore	614238	4744768
2003	Autumn	Lower	Off shore	622671	4746563

Appendix 3. Analysis of variance results for sauger catch per unit effort data from Lewis and Clark Lake gill nets during 2002 and 2003. Highlighted numbers are significant.

Source	Sum-of-squares	DF	Mean-square	F-ratio	P
Season	3.017	2	1.509	23.51	0.000
Zone	2.110	1	2.110	32.88	0.000
Location	1.602	1	1.602	5.3	0.000
Season*zone	0.681	2	0.340	24.96	0.006
Season*location	0.335	2	0.167	2.61	0.076
Zone*location	1.328	1	1.328	20.70	0.000
Season*zone*location	0.028	2	0.014	0.22	0.803
Error	13.091	204	0.064		

Appendix 4. Results of pairwise comparisons, within a season or zone, for two-way interactions for sauger catch per unit effort data from gill net catches in Lewis and Clark Lake during 2002 and 2003. Highlighted numbers are significant.

Source	Season	Zone	Comparison	DF	Difference	P
Season*zone	Spring	-	Lower>upper	204	-0.145	0.016
Season*zone	Summer	-	Lower>upper	204	-0.354	0.000
Season*zone	Autumn	-	Lower=upper	204	-0.095	0.115
Zone*location	-	Upper	Nearshore=offshore	204	0.015	0.752
Zone*location	-	Lower	Nearshore<offshore	204	0.329	0.000

Appendix 5. Analysis of variance results for walleye catch per unit effort data from Lewis and Clark Lake gill nets during 2002 and 2003. Highlighted numbers are significant.

Source	Sum-of-squares	DF	Mean-square	F-ratio	P
Season	3.308	2	1.654	21.118	0.000
Zone	0.001	1	0.001	0.016	0.900
Location	0.017	1	0.017	0.213	0.645
Season*zone	0.202	2	0.101	1.292	0.277
Season*location	0.179	2	0.089	1.140	0.322
Zone*location	0.585	1	0.585	7.462	0.007
Season*zone*location	0.469	2	0.234	2.993	0.052
Error	15.980	204	0.078		

Appendix 6. Results of pairwise comparisons within each season, zone, and location to examine the season*zone*location interaction for walleye gill net catch per unit effort data from Lewis and Clark Lake during 2002 and 2003. Highlighted numbers are significant.

Source	Season	Strata	Comparison	DF	Difference	P
Season*Zone*Location	Spring	Upper	Near=off	204	0.141	0.133
Season*Zone*Location	Spring	Lower	Near>off	204	-0.262	0.005
Season*Zone*Location	Summer	Upper	Near<off	204	0.208	0.027
Season*Zone*Location	Summer	Lower	Near=off	204	-0.057	0.544
Season*Zone*Location	Autumn	Upper	Near=off	204	0.017	0.858
Season*Zone*Location	Autumn	Lower	Near=off	204	0.060	0.523
Season*Zone*Location	Spring	Near	Upper<lower	204	-0.223	0.018
Season*Zone*Location	Spring	Off	Upper>lower	204	0.180	0.055
Season*Zone*Location	Summer	Near	Upper=lower	204	-0.055	0.555
Season*Zone*Location	Summer	Off	Upper>lower	204	0.209	0.026
Season*Zone*Location	Autumn	Near	Upper=lower	204	-0.049	0.602
Season*Zone*Location	Autumn	Off	Upper=lower	204	-0.092	0.326

Appendix 7. Analysis of variance results for sauger mean total lengths from gill net catches in Lewis and Clark Lake during 2002 and 2003. Highlighted numbers are significant

Source	Sum-of-squares	df	Mean-square	F-ratio	P
Season	73412.3	2	36706.1	4.454	0.012
Zone	5370.8	1	5370.8	0.652	0.420
Location	45644.4	1	45644.4	5.539	0.019
Season*zone	59410.3	2	29705.2	3.605	0.028
Season*location	190402.2	2	95201.1	11.552	0.000
Zone*location	12802.4	1	12802.4	1.553	0.213
Season*zone*location	62916.5	2	31458.3	3.817	0.022
Error	8051580.1	977	8241.1		

Appendix 8. Results of pairwise comparisons within each season, zone, and location to examine the season*zone*location interaction for sauger mean total length. Highlighted numbers are significant.

Source	Season	Strata	Comparison	DF	Difference	P
Season*Zone*Location	Spring	Upper	Near>off	977	-50.511	0.018
Season*Zone*Location	Spring	Lower	Near=off	977	-12.307	0.447
Season*Zone*Location	Summer	Upper	Near<off	977	66.919	0.002
Season*Zone*Location	Summer	Lower	Near=off	977	4.437	0.740
Season*Zone*Location	Autumn	Upper	Near<off	977	57.567	0.000
Season*Zone*Location	Autumn	Lower	Near<off	977	30.620	0.010
Season*Zone*Location	Spring	Near	Upper=lower	977	1.436	0.938
Season*Zone*Location	Spring	Off	Upper<lower	977	-36.767	0.058
Season*Zone*Location	Summer	Near	Upper=lower	977	-22.302	0.230
Season*Zone*Location	Summer	Off	Upper>lower	977	40.180	0.023
Season*Zone*Location	Autumn	Near	Upper=lower	977	11.842	0.403
Season*Zone*Location	Autumn	Off	Upper>lower	977	38.789	0.000

Appendix 9. Analysis of variance results for walleye mean total lengths in gill nets from Lewis and Clark Lake during 2002 and 2003. Highlighted numbers are significant

Source	Sum-of-squares	df	Mean-square	F-ratio	P
Season	21670.9	2	120835.5	9.286	0.000
Zone	264751.4	1	264751.4	20.347	0.000
Location	177936.4	1	177936.4	13.675	0.000
Season*zone	21337.3	2	10668.7	0.820	0.441
Season*location	99391.5	2	49695.8	3.819	0.022
Zone*location	24843.4	1	24843.4	1.909	0.167
Season*zone*location	185847.1	2	13012.6	7.141	0.001
Error	18099800.0	1391	13012.1		

Appendix 10. Results of pairwise comparisons within each season to examine the season*zone*location interaction for walleye mean total length. Highlighted numbers are significant.

Source	Season	Strata	Comparison	DF	Difference	P
Season*Zone*Location	Spring	Upper	Near=off	1391	13.862	0.415
Season*Zone*Location	Spring	Lower	Near=off	1391	-13.014	0.447
Season*Zone*Location	Summer	Upper	Near<off	1391	84.228	0.000
Season*Zone*Location	Summer	Lower	Near=off	1391	14.564	0.445
Season*Zone*Location	Autumn	Upper	Near=off	1391	2.132	0.866
Season*Zone*Location	Autumn	Lower	Near<off	1391	44.148	0.000
Season*Zone*Location	Spring	Near	Upper=lower	1391	4.548	0.779
Season*Zone*Location	Spring	Off	Upper=lower	1391	31.425	0.079
Season*Zone*Location	Summer	Near	Upper=lower	1391	5.636	0.776
Season*Zone*Location	Summer	Off	Upper>lower	1391	75.300	0.000
Season*Zone*Location	Autumn	Near	Upper>lower	1391	51.550	0.000
Season*Zone*Location	Autumn	Off	Upper=lower	1391	9.534	0.443

Appendix 11. Analysis of variance results for sauger mean relative weight values from gill net catches in Lewis and Clark Lake during 2002 and 2003. Highlighted numbers are significant.

Source	Sum-of-squares	df	Mean-square	F-ratio	P
Season	890.4	2	445.2	14.319	0.000
Zone	12.4	1	12.4	0.400	0.527
Location	44.0	1	44.0	1.4	0.234
Season*zone	813.7	2	406.8	13.1	0.000
Zone*group	190.7	2	95.3	3.1	0.047
Season*zone*location	235.3	2	117.6	3.8	0.02
Season*zone*location *group	413.4	4	103.4	3.3	0.010
Error	26988.4	868	31.1		

Appendix 12. Analysis of variance results for walleye mean relative weight values from gill net catches in Lewis and Clark Lake during 2002 and 2003. Highlighted numbers are significant.

Source	Sum-of-squares	df	Mean-square	F-ratio	P
Season	1669.9	2	834.9	26.5	0.000
Zone	491.3	1	491.3	15.6	0.000
Location	69.8	1	69.8	2.2	0.137
Group	7.8	2	3.9	0.123	0.884
Season*group	502.2	4	125.6	4.0	0.003
Zone*group	236.8	2	118.4	3.8	0.024
Error	33281.0	1057	31.5		

Appendix 13. Results of pairwise comparisons, within a season or zone, for two-way interactions for walleye mean relative weight values from gill net catches in Lewis and Clark Lake during 2002 and 2003. Group 1 is stock-quality length, group 2 is quality-preferred-length, and group 3 is preferred length. Highlighted numbers are significant.

Source	Season	Zone	Comparison	DF	Difference	P
Season*group	Spring	-	Group1>group2	1024	2.057	0.005
Season*group	Spring	-	Group1=group3	1024	0.979	0.673
Season*group	Spring	-	Group2=group3	1024	-1.078	0.646
Season*group	Summer	-	Group1<group2	1024	-2.290	0.037
Season*group	Summer	-	Group1=group3	1024	-1.330	0.563
Season*group	Summer	-	Group2=group3	1024	0.960	0.694
Season*group	Autumn	-	Group1=group2	1024	-0.366	0.535
Season*group	Autumn	-	Group1=group3	1024	-0.672	0.498
Season*group	Autumn	-	Group2=group3	1024	-0.306	0.770
Zone*group	-	Upper	Group1=group2	1024	-0.784	0.261
Zone*group	-	Upper	Group1=group3	1024	-1.509	0.306
Zone*group	-	Upper	Group2=group3	1024	-0.725	0.567
Zone*group	-	Lower	Group1=group2	1024	0.384	0.560
Zone*group	-	Lower	Group1=group3	1024	0.826	0.582
Zone*group	-	Lower	Group2=group3	1024	0.442	0.734

Appendix 14. Lewis and Clark Lake abiotic conditions during sampling. Conductivity values are corrected to 25 ^{0}C.

Date	Conductivity (micro-siemens)	Water Temperature (^{0}C)	Secchi Disk (m)
May 14, 2002	758	11.0	1.0
May 22, 2002	740	14.6	0.5
May 29, 2002	744	18.6	0.9
July 24, 2002	788	24.7	0.6
July 29, 2002	769	26.7	0.5
September 16, 2002	774	21.0	1.0
May 5, 2003	737	11.2	0.8
July 9, 2003	746	24.0	0.3
September 15, 2003	749	20.2	0.8